PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

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PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP2018/073219	29.08.2018	01.09.2017

International Patent Classification (IPC) or both national classification and IPC
INV. G01S17/89 G01S7/481

Applicant
KONINKLIJKE PHILIPS N.V.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:

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Date of completion of this opinion
see form PCT/ISA/210

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/EP2018/073219

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-13
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-3, 11
	No:	Claims	4-10, 12, 13
Industrial applicability (IA)	Yes:	Claims	1-13
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 US 2015/362585 A1 (GHOSH CHUNI LAL [US] ET AL) 17 December 2015 (2015-12-17)

D2 US 2017/115497 A1 (CHEN TONG [US] ET AL) 27 April 2017 (2017-04-27)

D3 US 2016/050401 A1 (GORDON EYAL [IL]) 18 February 2016 (2016-02-18)

D4 US 2012/038903 A1 (WEIMER CARL S [US] ET AL) 16 February 2012 (2012-02-16)

D5 US 2015/378011 A1 (OWECHKO YURI [US]) 31 December 2015 (2015-12-31)

D6 US 2016/033642 A1 (FLUCKIGER DAVID U [US]) 4 February 2016 (2016-02-04)

D7 DE 10 2008 021465 A1 (FRAUNHOFER GES FORSCHUNG [DE]) 5 November 2009 (2009-11-05)

1 The subject matter of claims 1-3 and 11 is new and involves an inventive step (Article 33(2)(3) PCT).

D1 is regarded as being the prior art closest to the subject-matter of **claim 1**, and discloses:

A time-of-flight depth camera comprising a VCSEL array (D1: [0017], [0092]),
an optical arrangement (D1: [0087]),
an evaluator (D1: [0095]) and
a light detector comprising at least one detector pixel (D1: [0093]),
wherein the VCSEL array or the optical arrangement are arranged to provide different illumination patterns in a reference plane in a defined field-of-view of the time-of-flight depth camera (D1: [0085]),
wherein the light detector is arranged to detect the different illumination

patterns (D1: [0093]),
wherein the evaluator is arranged to reconstruct a depth image of the field of view with a resolution of a predefined number of pixels P based on the detected different illumination patterns (D1: [0095]),
wherein a number of the detected different illumination patterns N is at least 5% of the predefined number of pixels P, preferably at least 10% of the predefined number of pixels and most preferred at least 20% of the predefined number of pixels P (D1: [0088] - scans the region, [0014]), wherein the VCSEL array is an addressable VCSEL array, wherein the VCSEL array is arranged to provide different illumination patterns by addressing different VCSELs of the VCSEL array (D1: [0027]).

The subject-matter of claim 1 therefore differs from this known time-of-flight depth camera in that

the optical arrangement comprises a replicating optical structure, wherein the replicating optical structure is arranged to replicate a light pattern provided by the VCSEL array across the illumination pattern such that the illumination pattern consists of two, three, four or more sub-illumination patterns, wherein the detector is arranged such that each detector pixel detects a corresponding sub-illumination pattern

and is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as to allow parallel processing and therefore a reduction of the reconstruction time of the depth image.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT). While D2 and D3 disclose a replicating structure (D2: [0130], [0133]; D3:), none of the found prior art hints at arranging a detector such that each detector pixel detects a corresponding sub-illumination pattern.

Claims 2 and 3 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

For the above reasons, the corresponding method according to **claim 11** is also new and involves an inventive step.

2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 4-10, 12, 13 does not involve an inventive step in the sense of Article 33(3) PCT.

2.1 Independent claims

Claim 4

D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses:

A time-of-flight depth camera comprising a VCSEL array (D1: [0017], [0092]), an optical arrangement (D1: [0087]),
an evaluator (D1: [0095]) and
a light detector comprising at least one detector pixel (D1: [0093]),
wherein the VCSEL array or the optical arrangement are arranged to provide different illumination patterns in a reference plane in a defined field-of-view of the time-of-flight depth camera (D1: [0085]),
wherein the light detector is arranged to detect the different illumination patterns (D1: [0093]),
wherein the evaluator is arranged to reconstruct a depth image of the field of view with a resolution of a predefined number of pixels P based on the detected different illumination patterns (D1: [0095]),
wherein a number of the detected different illumination patterns N is at least 5% of the predefined number of pixels P, preferably at least 10% of the predefined number of pixels and most preferred at least 20% of the predefined number of pixels P (D1: [0088] - scans the region, [0014]), wherein the VCSEL array is an addressable VCSEL array, wherein the VCSEL array is arranged to provide different illumination patterns by addressing different VCSELs of the VCSEL array (D1: [0027]).

The subject-matter of claim 1 therefore differs from this known time-of-flight depth camera in that

the optical arrangement comprises a replicating optical structure, wherein the optical arrangement is arranged to provide different illumination patterns by changing an optical property of the optical arrangement.

The problem to be solved relates therefore to providing different illumination patterns.

D3 discloses an optical arrangement are arranged to provide different illumination patterns for three dimensional imaging (D3: abstract). The optical arrangement comprises a replicating optical structure (D3: [0394] - "several

copies of a basic recurring unit"), wherein the optical arrangement is arranged to provide different illumination patterns by changing an optical property of the optical arrangement (D3: [0395] - "shifting DOE 219 itself").

D3 is structurally very similar to D1 and is therefore considered by the skilled person for solving the problem. It provides a solution to the problem, the disclosed features have the same technical effect as the differentiating features of claim 1, to provide different illumination patterns.

The subject-matter of claim 4 does therefore not involve an inventive step.

The corresponding method according to **claim 12** and corresponding computer program product according to **claim 13** does for the same reasons not involve an inventive step.

2.2 The dependent claims do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

Claim 5
Shifting the DOE (D3: [0395]) means that O is at least two and a number of N larger that 4 is suggested by the seven laser elements shown in Fig. 43 of D3.

Claim 6
Shifting the DOE (D3: [0395]) is changing a spatial relationship.

Claim 7
D2 utilises in an embodiment two diffractive optical elements (D2: [0113]). Using two diffractive optical elements is therefore regarded as a slight modification which is obvious to the skilled person.

Claim 8
Micromirror devices as spatial light modulators are known from D7 (D7: [0042]) and an obvious addition to diffractive optical elements.

Claim 9
D6 and D7 already disclose single pixel imaging (D7: [0044], Fig. 2). Using an alternative, known pattern projector is considered obvious.

Claim 10
A number of detected different illumination patterns less than the number of pixels is considered common in cameras as that of D1.